

Three-dimensional magnetotail reconnection: Geotail and Cluster observations

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In this study, we investigate the conditions required for reconnection at the dawn and far-dusk sides, which is significantly more rare than reconnection near midnight. We analyze more than 2 decades of Geotail and Cluster encounters with the near-Earth magnetotail reconnection site. Previous studies have suggested that reconnection onset occurs on the duskside, near midnight, and that reconnection sites may subsequently expand in the dawn-dusk direction with the cross-tail current. We find that reconnection on the duskside, near midnight can occur for comparably low and short-duration solar wind energy input. Reconnection sites on the dawn and far-dusk sides require sustained high solar wind energy input, suggesting that longer-cross-tail-length x-lines require sustained magnetotail reconnection. We also investigate the properties of the current sheet during 16 Cluster encounters with the reconnection site. We find the current sheet to be thinnest on the duskside, near midnight. Approximately where previous studies have identified the duskward edge of the reconnection site, we find the current sheet thickness to be larger than the ion inertial length, consistent with predictions from theoretical models of 3D reconnection. We compare the geomagnetic activity levels (Kp, AL, Dst) for each of the reconnection site observations. Consistent with the above solar wind activity dependence, we find that reconnection can be observed on the duskside, near-midnight, during extremely quiet times, but is only observed on the dawn and far-dusk sides during periods of highly elevated activity. This suggests that reconnection at the dawn and far dusk sides form as a result of cross-tail expansion during intervals where the total reconnection rate in the magnetotail is abnormally high. Finally, we use our work to make predictions for the upcoming MMS tail season.

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